DOCUMENT RESUME

ED 193 061 SE 032 963

AUTHOR Arena, John E.; And Others
TITLE Computations About the Sources and Conservation of Energy.
SPONS AGENCY Florida State Dept. of Education, Tallahassee. Office of Environment Education.
PUB DATE 79
NOTE 76p.; Contains occasional light and broken type.

EDRS PRICE MF01/PC04 Plus Postage.
DESCRIPTORS Elementary Secondary Education; *Energy; Energy Conservation; Environmental Education; *Interdisciplinary Approach; Junior High Schools; *Mathematics Education; Mathematics Instruction; *Resource Materials; *Secondary School Mathematics; Secondary School Science
IDENTIFIERS *Energy Education

ABSTRACT

Energy-related concepts are the subject of mathematics problems in this supplementary workbook for secondary school students. Exercises involving light, heat, motion, and energy conservation assist students in understanding whole numbers, decimals, fractions, ratios, proportions, percents, and the creation and interpretation of graphs. The individual energy topics and the associated calculations are described together in order to facilitate comprehension of both mathematical operations and scientific concepts. For teachers, each problem is coded according to the type of math skill required. Also provided are a glossary and an answer key. (WB)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED193061

COMPUTATIONS ABOUT the sources and conservation of ENERGY

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL NATIONAL INSTITUTE OF EDUCATION POSITION OR POLICY.

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY
C. Richard Tillis
TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

SE 032 963

WRITING COMMITTEE

JOHN E. ARENA
DIRECTOR, ESEA TITLE IVC PROJECTS
BROWARD COUNTY, FLORIDA

LAWRENCE G. INSEL
ADMINISTRATIVE ASSISTANT, CORAL SPRINGS HIGH SCHOOL
BROWARD COUNTY, FLORIDA

LAURENCE R. WANTUCK
MATHEMATICS SUPERVISOR K-12
BROWARD COUNTY, FLORIDA

PUBLISHED BY:

FLORIDA OFFICE OF ENVIRONMENTAL EDUCATION
DEPARTMENT OF EDUCATION
TALLAHASSEE, FLORIDA

TABLE OF CONTENTS

I. INTRODUCTION..... 3

II. ENERGY FOR MOVING THINGS..... 5
(Transportation- Recreation)

III. ENERGY FOR HEAT AND LIGHT..... 26
(Energy in the Home)

IV. OUR ENERGY RESOURCES..... 41
(Sources of Energy)

V. APPENDIX

GLOSSARY..... 56
CONVERSION FACTORS..... 61
ANSWER KEY..... 63
BIBLIOGRAPHY..... 73

CODING SYSTEM FOR MATHEMATICAL STRANDS

W - WHOLE NUMBERS

F - RATIONAL NUMBERS IN FRACTIONAL FORM

D - RATIONAL NUMBERS IN DECIMAL FORM

P - RATIO, PROPORTIONS AND PERCENT

S - STATISTICS (CREATING AND INTERPRETING GRAPHS)

I

INTRODUCTION

Almost every one is now fully aware that mankind is facing the most serious problem it has ever encountered—the energy crisis. Unless this problem is solved, a radical change will occur in the way we live. We will have to give up the luxuries of automobiles and airplanes for convenient travel, air conditioning and heating for comfort, electrical appliances to reduce our daily chores, power boats for recreation, and many more things we have accepted as a way of life. Can you imagine living without these things?

Science and technology have created this problem by man's successful attempt to provide himself with comfort, convenience, and escape from laborious tasks. Science and technology will eventually solve the problem if sufficient time is provided.

Time is the key to success. It can only be gained if each of us can learn to consume less energy until solutions are found. If we do not cooperate in an effort to gain time, chaos will soon be upon us. We may even be denied the resources needed to solve the problem—then what shall we do?

To act intelligently on the problem, it is necessary that we understand the basics of what energy is. Energy is simply the ability to do work. All applied energy is in the form of motion. This is called kinetic energy. A hammer can drive a nail because it has motion. An object has heat energy because its molecules are in motion. An electric

current has energy because electrons are in motion.

All stored energy has the ability to do work when set in motion. This is called potential energy. A battery stores electrons but provides no energy until the electrons are allowed to move. Gasoline in a fuel tank stores chemical energy. It provides no energy until a chemical action is made to occur which causes rapid motion of molecules.

There is a certain amount of energy in our world and it never increases or decreases. Energy cannot be created or destroyed—it can only be changed from one form to another. Under certain circumstances a particular form of energy is useful to us. The same form of energy under different circumstances would be wasted.

For example, we need to supply heat energy to make water hot for cleaning purposes. We need to remove heat energy from a refrigerator to keep food cool. Maybe some day we will take the heat energy out of a refrigerator where we do not want it and use it in a water heater where we need it.

The problems and exercises you will be doing from this book will consider ways to conserve energy. By doing these exercises you will be able to identify energy conservation measures that best apply to you. In this way you can better do your part in helping to solve the energy problem. You will also be able to save much of your money as the cost of energy continues to increase.

Learn about energy so we can keep the way of life that we have worked so hard and so long to get!

II

ENERGY FOR MOVING THINGS

WHAT IS ENERGY?

It is not a simple matter to define energy in a way that is easily understood by people not trained in science. The most frequently used definition of energy is the ability to do work. But what is work?

Work implies accomplishing something. No work is ever done without, in one way or another, involving motion. Something has to be moved to accomplish work. To measure how much work is done, two things have to be considered: (1) the force (push or pull) needed to move the object; and (2) the distance that this object is moved. This can be put in the form of a mathematical equation:

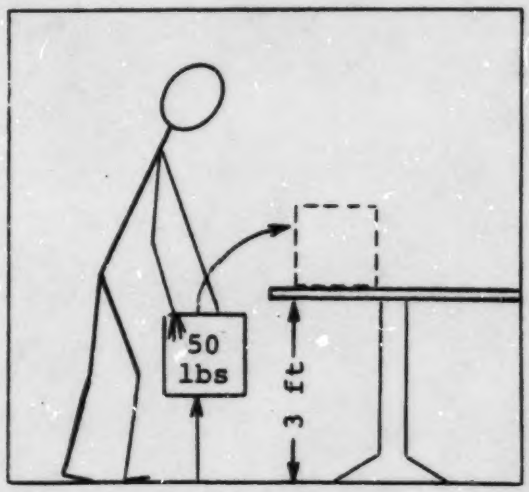
Work = Force x Distance

W = F x D

This can best be illustrated by doing a few problems on calculating the amount of work done.

SAMPLE PROBLEM

How much work does a boy do lifting a 50-pound box from the floor to the top of a table which is 3 feet above the floor?



SOLUTION:

To lift the 50-pound box the boy would have to apply an upward force of 50 pounds. So the force (F) is 50 pounds and the distance (D) the force must act is 3 feet.

$W = F \times D$

$W = 50 \text{ pounds} \times 3 \text{ feet}$

$W = 150 \text{ foot-pounds}$ (ANSWER)

As you can see, the unit of measurement for work in the customary system is foot-pounds, abbreviated ft-lbs.

Let us do the same problem using the metric system of measurement.

SAMPLE PROBLEM

Fifty pounds is equal to about 22.7 kilograms and 3 feet is about 0.91 meters. Therefore the work done is:

$W = F \times D$

$W = 22.7 \text{ kilograms} \times 0.91 \text{ meters}$

$W = 20.66$ kilogram-meters (ANSWER)

NOTE: For convenience we shall use the units kilogram for force and kilogram-meters for work. Actually, the unit for force in the metric system is the newton, and the unit for work is joule. (See appendix for definitions of these units)

(D) 1. Suppose the weights of your textbooks are as follows:

Mathematics:	0.9 kg
Science:	1.1 kg
Social Studies:	1.3 kg
English:	2.0 kg

Determine the amount of work required (kilogram-meters) to move these four books from the floor to the top of a desk 70 cm high.

(W) 2. The rungs on a vertical ladder used to reach the top of a 150-foot high water tower are one foot apart. Calculate the work (foot-pounds) required for a 200-pound man to climb a total of:

a. 15 rungs

b. 45 rungs

c. 150 rungs

(W) 3. Compute the force required to lift a 20-foot boat weighing 2 500 pounds to a height of 8 feet.

Since energy is the ability to do work, the amount of energy used is equal to the amount of work done. Therefore, the units of measurement for energy are the same as the units for work—that is, foot-pounds in the customary system and kilogram-meters in the metric system.

How much energy is used to do the following things:

(W) 4. With a force of 12 pounds pull a wagon a distance of 5 feet?

(D) 5. Lift a bag of cement weighing 45.5 kilograms to the top of a wall which is 1.2 meters high?

To conserve energy it is evident that you must accomplish something with the minimum amount of work. This principle was discovered many years ago when man first invented the wheel. He discovered it required less force, and, consequently, less work, to roll something than to drag it. In the process of doing work, the less resistance or friction you have to work against, the less energy you will expend.

6. Suppose your car averages 25 miles per gallon of gasoline on long trips when the suitcases are on a luggage rack on top of the car. If by putting the luggage in the car (reducing air friction) you get 8 percent better mileage,

(P) a. compute the number of miles per gallon your car would obtain with the luggage in the car.

(W) b. compute the number of gallons, to the nearest tenth, you would use travelling from Tallahassee, Florida, to Key West, Florida, (606 miles), with the luggage:

i. on top of the car

ii. in the car.

(D) c. assuming a cost of 63.9¢ per gallon for gasoline, determine the money you would save by packing the luggage in the car instead of on the roof on your trip to Key West.

7. Underinflated tires create a loss in gasoline mileage of up to 10 percent. Suppose your compact car averages 27 miles per gallon with properly inflated tires and you travel 15 000 miles each year,

(W) a. determine the number of gallons of gasoline you would use with properly inflated tires (nearest tenth of a gallon).

(P) b. assuming your tires were underinflated, causing an 8 percent loss in mileage, compute the number of miles per gallon you would obtain (nearest tenth).

(D) c. determine the number of gallons of gasoline you would use with improperly inflated tires during the year (nearest tenth).

(D) d. at the rate of 63.9¢ per gallon, compute the money you would save by having properly inflated tires.

(D) 8. Pulling a trailer with an automobile will always result in a decrease in gas mileage because of the added weight and friction. Some trailers are streamlined in design to minimize this loss of efficiency but some are not. A certain streamlined trailer has been found to cause gas mileage to be reduced by 21 percent. Another trailer of about the same size and weight but not streamlined has been found to reduce gas mileage by 37 percent. Assume your car averages 16 miles per gallon when not pulling a trailer, compute, to the nearest tenth, the number of gallons of fuel you would use round-trip from Pensacola to Miami, a total trip of 1 326 miles, when pulling:

a. the unstreamlined trailer.
b. the streamlined trailer.

(D) 9. Determine the savings in the cost of gasoline by using a streamlined trailer for the trip in Exercise 8 if gasoline costs an average of 67.9¢ per gallon.

The most energy-consuming factor in the process of doing work is the time element. To do work rapidly requires

a greater force and, consequently, more energy.

Power is a measure of the speed with which work is done. To accomplish a certain amount of work over a long period of time requires little power and consumes little energy. To accomplish the same amount of work in a short time requires more power and consumes more energy.

For example, if you climb a staircase very slowly, you will not be tired when you get to the top. If you run up the staircase, when you reach the top you will feel your heart beating rapidly and you will be panting for breath.

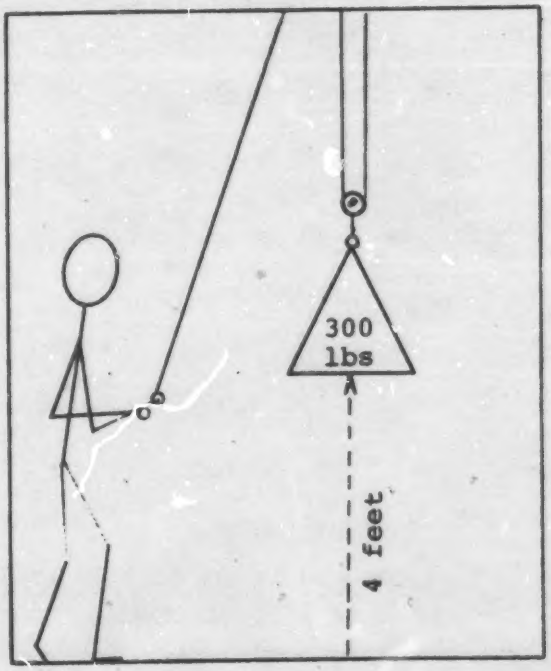
Power can be measured mathematically by dividing the amount of work done by the time it took to do it.

$$\text{Power} = \frac{\text{Work}}{\text{Time}}$$

$$P = \frac{W}{t}$$

SAMPLE PROBLEM

A man using a block and tackle lifts a 300-pound weight to a height of 4 feet in 40 seconds. How much power was he applying?



SOLUTION:

First you must find the amount of work accomplished.

$$W = F \times D$$

$$W = 300 \text{ pounds} \times 4 \text{ feet}$$

$$W = 1\ 200 \text{ foot-pounds}$$

Now you can calculate the power by dividing the work done by the time.

$$P = \frac{W}{t}$$

$$P = \frac{1\ 200}{40} = 30 \frac{\text{foot-pounds}}{\text{second}} \quad \text{(ANSWER)}$$

(W) 10. At Coral Springs High School, the second floor is 18 feet above the first floor. Compute the power in foot-pounds per second required for a 110-pound student to climb the stairs in:

a. 30 seconds

b. 20 seconds

c. 10 seconds.

(W) 11. A rope hanging from the ceiling of a gymnasium is 9 meters long. Calculate the power in kilogram-meters per second required for an athlete weighing 68 kg to climb the rope in:

a. 1 minute

b. 45 seconds

c. 1/2 minute

d. 15 seconds

(F) 12. If 60 foot-pounds per second of power is required to do a certain task, determine the power required to do the same task in:

a. 1/2 the time

b. 1/3 the time

c. 1/4 the time

You are probably familiar with the word horsepower as used to describe the power of engines. One horsepower simply means doing work at the rate of 550 foot-pounds per second. Therefore, a 10-horsepower outboard motor can do 550 x 10 = 5 500 foot-pounds of work in one second.

(W) 13. Convert the following measurements of power to horsepower:

a. 3 850 foot-pounds per second

b. 8 250 foot-pounds per second

c. 27 500 foot-pounds per second

(W) (F) 14. Determine the equivalent number of foot-pounds per second of power generated by the following engines:

a. 2 1/2 H.P. lawnmower

b. 55 H.P. outboard

c. 130 H.P. inboard

d. 225 H.P. automobile

Power can make things move faster but the rate at which energy is consumed is very high. For example, look at the following chart which gives the speed and miles per gallon

of a boat using different outboard motors.

HORSEPOWER	MILES PER HOUR	MILES PER GALLON
5	8.2	13.5
9.8	16.7	12.4
25	27.4	9.6
35	32.1	7.8

(D) 15. Using the above chart, calculate the time it would take to travel from Elliot Key Park to Homestead Bayfront Park, a distance of 10 miles, using outboard motors of the following horsepower:

a. 5

b. 9.8

c. 25

d. 35

(D) 16. Determine the number of gallons of gasoline you would use to travel from Elliot Key to Homestead Bayfront Park using outboard motors of the following horsepower:

a. 5

b. 9.8

c. 25

d. 35

(D) 17. At the price of 63.9¢ per gallon, determine the cost of the gasoline used in Parts a thru d of Problem 16.

(D) 18. It probably appears from the results of Problems 15, 16, and 17 that the savings in money is mimimal compared to the increase in time required to travel the 10 miles from Elliot Key to Homestead Bayfront Park.

Suppose gasoline was not readily available and you were limited to 10 gallons per month to use for your boat:

a. Compute the maximum number of one-way trips you could make between Elliot Key and Homestead Bayfront Park using each of the engines listed in the above chart.

b. Which engine do you think would be the best choice under these conditions?

With automobiles the greatest consumption of fuel occurs at high speeds or very rapid acceleration. Most automobiles get about 28 percent better mileage at 50 miles per hour (80 kilometers per hour) than at 70 miles per hour (113 kilometers per hour).

An automobile travelling at 55 miles per hour (89 kilometers per hour) gets about 21 percent better mileage than when travelling at 70 miles per hour.

(P) 19. Suppose your family plans to travel from Fort Lauderdale to Disney World (a distance of 350 kilometers). Assuming your car averages 7 kilometers per liter of gasoline at the constant rate of 113 kilometers per hour, compute the number of kilometers per liter you would obtain travelling at a constant rate of:

a. 80 kilometers per hour

b. 89 kilometers per hour

(D) 20. Compute the number of liters of gasoline you would use in Problem 19 above, travelling at a constant rate of:

a. 113 kilometers per hour (an illegal rate of speed)

b. 89 kilometers per hour

c. 80 kilometers per hour.

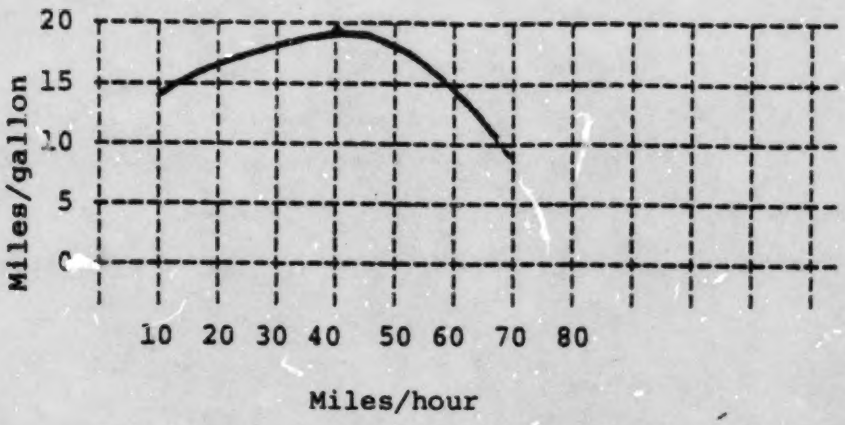
(D) 21. Assuming a price of 15.9¢ per liter of gasoline, compute the cost to travel a distance of 350 kilometers at the constant rate of:

a. 113 kilometers per hour

b. 89 kilometers per hour

c. 80 kilometers per hour.

The graph below indicates the miles per gallon the average automobile gets at different speeds.



(S) 22. Use the above graph to determine the number of miles per gallon the average automobile gets at the following speeds:

a. 10 miles per hour

b. 40 miles per hour

c. 70 miles per hour (an illegal speed)

Suppose you wish to make a round trip from Apalachicola, Florida, to Belle Glade, Florida, a total distance of 900 miles. Use the information in the above graph to solve the following problems:

(W) 23. Calculate the driving time it would take to make the round trip, assuming a constant rate of:

a. 40 mph

b. 55 mph

c. 70 mph (an illegal speed)

(W) 24. Compute the number of gallons of gasoline you would use, making the above round trip at the following constant speeds:

a. 40 mph

b. 55 mph

c. 70 mph (an illegal speed)

(D) 25. Assuming a price of 68.9¢ per gallon of gasoline, compute the cost for gasoline to make the above round trip at the following constant rate of speed:

a. 40 mph

b. 55 mph

c. 70 mph (an illegal speed)

As another illustration of how speed affects energy consumption, look at the following data on the performance of a 37-foot Tollycraft trawler which was presented in the October 1977 issue of Boating magazine.

ENGINE REVOLUTIONS PER MINUTE	MILES PER HOUR	GALLONS OF FUEL PER HOUR	MILES PER GALLON
1250	7.85	2.0	_____
1500	9.15	3.6	_____
1750	9.93	4.8	_____
2000	11.15	6.6	_____
2250	11.73	8.5	_____
2500	13.59	11.0	_____
1750	15.70	15.2	_____

(D) 26. Complete the above table for miles per gallon.

(S) 27. Construct a line graph illustrating the relationship between the speed of the Tollycraft trawler and the fuel consumed in gallons per hour.

(D) 28. The distance between Miami, Florida, and Bimimi in the Bahamas is approximately 50 miles. Discounting the effect of wind, wave action, and tides, determine the time required to make the trip at the following speeds:

a. 7.85 mph

b. 11.73 mph

c. 15.70 mph

(D) 29. Use the preceding chart and the results from Problem 26 to find the number of gallons of gasoline required to make the trip at the following speeds:

a. 7.85 mph

b. 11.73 mph

c. 15.70 mph

(D) 30. Assuming a price of 65.9¢ per gallon, compute the cost of the gasoline required to travel from Miami to Bimini in a Tollycraft at each of the following speeds:

a. 7.85 mph

b. 11.73 mph

c. 15.70 mph

(S) 31. Do you think that the savings in time obtained by increasing the speed from 7.85 mph to 15.70 mph is worth the increased fuel consumption and related costs?

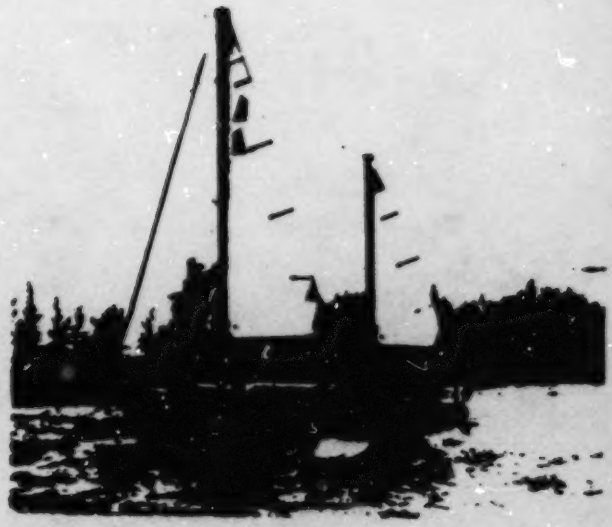
You are probably wondering why fuel consumption increases so rapidly at high speeds. Most people do not really understand why. The following true story will illustrate this:

A young lady was stopped by a state trooper for going 70 miles per hour on the Florida Turnpike. When the trooper asked why she was going so fast she replied, "I'm running out of gasoline and I am in a hurry to get to the next gas station."

Several hundred years ago, scientists discovered that not only does energy depend on the speed of an object but that energy increases with the square of the speed. This means that if a car doubles its speed its energy will be four times greater. If the car triples its speed its energy will be nine times greater.

This explains why man's desire to do things quickly is one reason why we have an energy crisis.

This boat gets about 1 mile per gallon of fuel



This boat gets about 200 miles per gallon of fuel

To appreciate the seriousness of not considering speed effects on fuel consumption, work out the following problems:

(W) 32. Suppose an automobile travelling at 30 mph has moving energy equal to 120 000 foot-pounds. Compute the moving energy the same car would have at:

a. 60 mph

b. 90 mph

NOTE: You should know that if a car has a certain amount of energy due to its motion, it will take the same amount of energy to cause it to stop.

Now that you have learned about work, energy, and power, as applied to moving things, you should be able to draw your own conclusions on how to conserve energy. You should keep in mind that an effective energy conservation plan depends

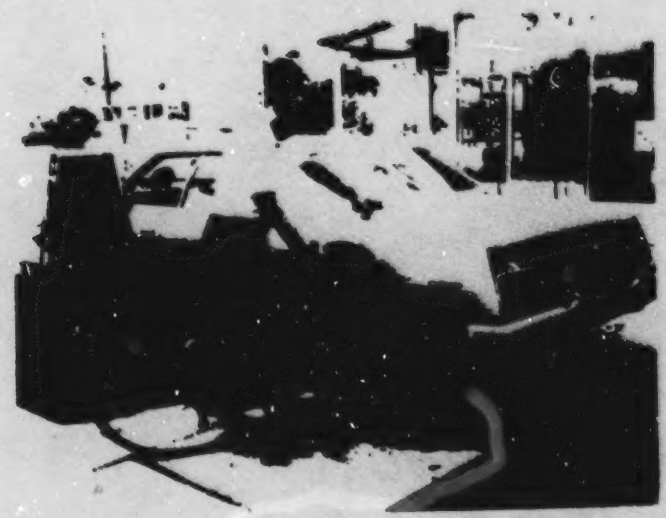
upon everyone contributing their share.

This is not a problem the government can solve. This is a problem that can only be resolved by the people. If you think your contribution is only a drop in the bucket and, therefore, not worth the effort, work out the following problems and see how much your effort is really worth.

(D) 33. Approximately 40 million automobiles are used to travel to and from work each day in the United States. It has been estimated that an average savings of 3.2 gallons per week for each car has been obtained by reducing the speed limit from 60 mph to 55 mph.

a. Compute the number of gallons of gasoline estimated to be saved weekly by lowering the speed limit to 55 mph.

b. At an average price of 63.9¢ per gallon, determine the savings per week for the 40 000 000 automobiles travelling to and from work.



The following table gives the average loss in efficiency of an automobile that appears to be running properly but actually may have one or more of the problems listed.

PROBLEM CAUSE	LOSS MILES PER GALLON	LOSS KILOMETERS PER LITER
POORLY ADJUSTED CARBURETOR	3	1.3
MISFIRING SPARK PLUG	2	0.85
IGNITION OUT OF TIME	2	0.85
DIRTY AIR FILTER	1	0.42
WORN BREAKER POINTS	2	0.85

34. Assuming that the average automobile in the United States is driven 12 000 miles (19 308 kilometers) in a year and averages 15 miles per gallon (6.4 kilometers per liter), determine the following:

(S) a. The number of kilometers per liter of fuel lost by an automobile having a spark plug that is misfiring.

(S) b. The number of miles per gallon of fuel lost by an automobile having a poorly adjusted carburetor.

(D) c. The number of gallons of gasoline wasted in a year by an automobile having its ignition system out of time and a dirty air filter.

(D) d. The amount of money wasted by the automobile in Problem c if gasoline costs 63.9¢ per gallon.

(W) e. The number of gallons of gasoline wasted each year by an estimated 2 000 000 cars that have a combination of problems resulting in an average loss of 3 gallons per mile.

(W) f. The amount of money wasted in one year by the 2 000 000 automobiles in Problem e.

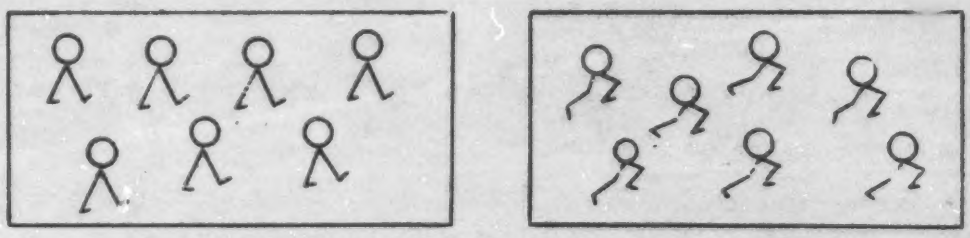
NOTE: Look at your answer to Problem 34c. It may not seem too significant to you. However, look at your answer to Problem 34e. Do you think it is significant now?

III

ENERGY FOR HEAT AND LIGHT

So far we have considered one form of energy which is called mechanical energy. But energy comes in many different forms, such as heat, light, and electricity. As was said before, all energy involves motion of some kind so you may be wondering why heat is a form of energy.

You cannot directly see the motion involved in heat energy because the motion is in the atoms and molecules that make up the substance and these are too small to be seen. If something is cold its atoms move at relatively low speeds. When the substance absorbs energy from an outside source its atoms move much faster.



cold air hot air

The temperature of a substance is actually a measure of the speed of motion of its molecules.

The total heat energy of a substance depends on both its temperature and the amount of matter it contains.

Therefore, the total heat energy of a substance depends upon the amount of matter it contains and how fast the molecules that make up this matter are moving.

In the case of electrical energy the motion is in the movement of tiny electrical particles called electrons going through the wire conductor. The amount of energy going through a wire depends upon how many electrons are moving past a point in one second (amperes) and the amount of pressure causing them to move (volts).

Electrical power is determined by volts and amperes working as a team. Neither term by itself gives you a measure of electrical power for turning motors or developing heat or light. For example: If you have 50 000 volts available but no free electrons to flow (amperes) there can be no power. Or, if you have enough free electrons in a circuit to provide a flow of 1 000 amperes, there will be no power unless there is voltage to make them flow. But, if you combine 50 000 volts and 1 000 amperes, you have power enough for a small town.

In order to get a measure that shows what volts and amperes amount to in power, you simply multiply the two together to get a new term—watts.

Volts x Amperes = Watts

(Pressure) x (Current Flow) = (Power)

SAMPLE PROBLEM

How many watts of power are available from 1 ampere flowing through a 115 volt circuit?

SOLUTION

Since watts = volts x amperes

we have watts = 115 x 1

watts = 115 (ANSWER)

SAMPLE PROBLEM

A room heater is rated at 1 650 watts. If you plug it into a 115 volt circuit, how many amperes are needed to operate the heater?

SOLUTION

Since watts = volts x amperes

we have 1 650 = 115 x amperes

or $\frac{1\ 650}{115}$ = amperes

14.38 = amperes (ANSWER)

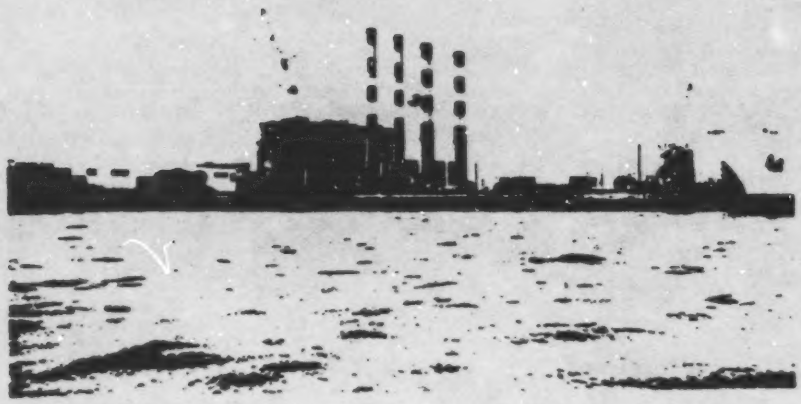
(D) 1. Suppose you have a 230 volt circuit with a current flow of 4.3 amperes. Determine the number of watts in the circuit.

(W) 2. A percolator is rated at 440 watts. If you plug it into a 115 volt circuit calculate the number of amperes of current required to operate the percolator.

(W) 3. Suppose you have a hair dryer plugged into a 110 volt circuit. If the dryer draws 11 amperes current, determine the power rating of the dryer.

(W) 4. An electric motor rated at 3 H.P. is plugged into a 230 volt circuit. Determine the number of amperes of current required to operate the motor. (746 watts = 1 H.P.)

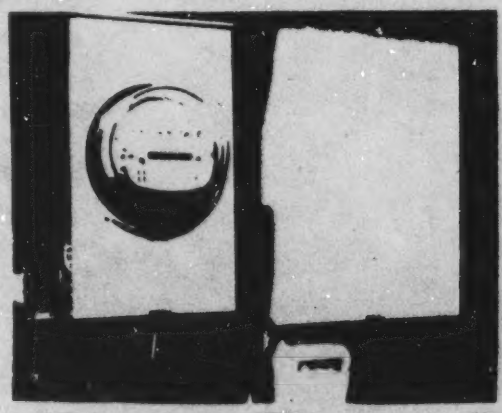
If you get a part-time job you will probably be paid by the hour. You pay for electrical energy in the same way. For example: Suppose you are operating a 1 H.P. motor, fully loaded, for 10 hours. (Remember 1 H.P. = 746 watts.) Multiplying 746 watts by 10 hours, you get 7 460 watt-hours. Watt-hours are such small units of electrical energy that power suppliers such as Florida Power and Light Company sell them to you by the 1 000. Each unit of 1 000 watt-hours is called a kilowatt-hour.



HOW TO READ YOUR ELECTRIC METER

The meter contains five dials, numbered from 0 to 10 and geared together. A special electric motor that speeds up or slows down as more or less electricity is being used turns the gears that operate the dials.

Starting from the left side the dials read values of 10 000, 1 000, 100, 10, and 1, as shown below.



5th digit 4th digit 3rd digit 2nd digit 1st digit

The pointer on each dial will usually be between two numbers. Always take the lower of the two numbers. For example, look at the set of dials below:

[4] [5] [0] [2] [9]

THESE DIALS READ 45 029 KILOWATT-HOURS

SAMPLE PROBLEM

How many kilowatt-hours (kw-h) of energy would be used by a 3 H.P. motor operating at full power for 10 hours?

SOLUTION

1 H.P. = 746 watts

3 H.P. = 3 x 746 = 2 238 watts

Since the motor is in operation for 10 hours, we have:

2 238 x 10 = 22 380 watt-hours used.

Dividing by 1 000, we have

$$\frac{22\ 380}{1\ 000} = 22.38 \text{ kilowatt-hours used.}$$

(W) 5. Compute the number of kilowatt-hours of energy used by:

a. a 150 watt light bulb left on for 8 hours.

b. a 1 200 watt electric hair dryer used for 15 minutes.

NOTE: You must convert minutes to hours.

c. a 10 000 Btu air conditioner requiring 2 000 watts of power, running constantly for 1 hour.

d. a refrigerator requiring 885 watts of power, operating for a period of 4 hours.

(D) 6. The cost of electrical energy in Florida is about 4.5¢ per kilowatt-hour. Suppose you use 3 000 kw-h of energy during the month of August. Compute the cost of this energy.

(D) 7. A refrigerator averages 60 watts of power per hour during a 30-day period of time.

a. Compute the number of kilowatt-hours of energy used per month.

b. Determine the cost of operating the refrigerator during the month.

(D) 8. Suppose you use the hair dryer in Problem 5b above for 15 minutes each day for 1 month (30 days). Calculate the cost of the energy required to operate the dryer.

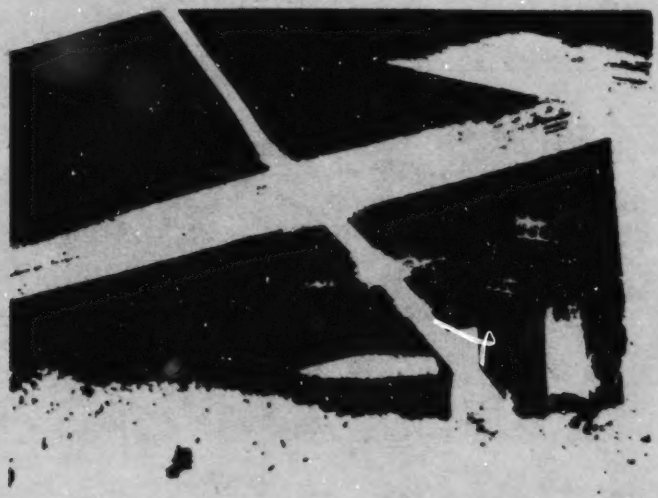
Conserving energy in the home is not just a matter of doing a few things differently. A significant reduction will occur only when you apply many energy-saving methods at one time. In other words, it is a matter of little savings in many different ways that add up to big savings at the end of the year.

The greatest amount of energy used in a home is for keeping the house at a comfortable temperature. Therefore, proper insulation of the house is the most important energy-saving factor.

Insulation in the ceiling does the most good per square foot of area. Up to 25 percent of heat loss and 40 percent of heat gain occurs through the ceiling. Just 3 inches of good insulation in the ceiling provides an average fuel saving of 26 percent.

Two inches of insulation in the exterior walls of a

house will reduce fuel consumption by an average of 8 percent.



9. Suppose your central air conditioner uses an average of 2 000 watts of power per hour.

(W) a. Compute the number of kilowatt-hours of energy used during 1 month (30 days).

(D) b. At the rate of 4.5¢ per kilowatt-hour, determine the cost of operating the air conditioner for 1 month.

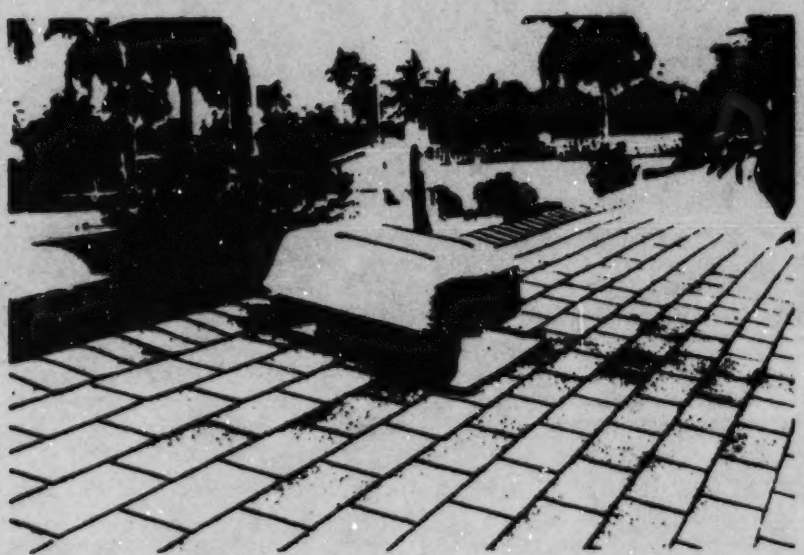
(P) c. Suppose you insulate your ceiling with 3 inches of good insulation. Determine the savings on the cost of air conditioning your home during 1 month.

(P) d. Two inches of insulation in the exterior walls of a house will reduce fuel consumption by an average of 8 percent. Determine the savings on the cost of air conditioning your home each

month if you had this type of insulation.

(P) e. Assuming you had both ceiling and wall insulation, calculate the cost of air conditioning your home for 1 month.

The attic of your house can trap air which will be heated by the sun's energy absorbed by the roof. The temperature of this air can be over 130 degrees Fahrenheit (50.5°C). By using a thermostatically controlled or wind-powered attic ventilator during the months that you use air conditioning, the temperature of the air in the attic can be reduced by as much as 60°F (33°C). This will reduce the heat transmitted into the house through the ceiling. The resulting savings could be about 7 percent less air conditioning required in a well insulated house and as much as 22 percent in a poorly insulated house.



(D) 10. Suppose you use 2 000 kw-h of electricity per month to air condition your home. At the rate of 4.5¢ per kilowatt-hour, compute the cost of air conditioning your home.

(P) 11. Calculate the monthly savings you would obtain on the cost of air conditioning the house in Problem 10 above if you installed a thermostatically-controlled attic ventilator and your house was

a. poorly insulated

b. well insulated.

A very important factor in conserving energy is the setting of the thermostat. Studies have shown that 78°F (25.6°C) is comfortable for the summer and 65°F (18.3°C) can be adequate for the winter with proper clothing.

For each degree Celsius (°C) that you reduce the temperature below 25.6°C when using air conditioning, you will consume about 7 percent more electricity. (This 7 percent is cumulative.)

For each degree Celsius (°C) that you increase the temperature above 18.3°C when using the heating unit, you will consume about 5.5 percent more fuel or electricity.

12. Suppose your air conditioner uses 1 500 kw-h of electricity each month when the thermostat is set at 25.6°C.

(P) a. If you set the thermostat at 22°C, determine the additional number of kilowatt-hours of

electricity per month required to air condition the house.

(D) b. At the rate of 4.5¢ per kilowatt-hour, calculate the increase in the electric bill caused by reducing the thermostat to 22°C.

(F) 13. Air leakage is another important factor in heating or cooling a house. Your front door is probably 80 inches high and 36 inches wide. If there was only a 1/8-inch crack around the door, determine the actual number of square inches of opening to the outside this would amount to.

One of the most energy-consuming things we do is heating water. In fact, it takes more heat energy to increase the temperature of water than any other substance known.

The unit used to measure heat energy in the customary system of measurement is the British thermal unit (Btu). One Btu is the amount of heat needed to raise the temperature of one pound of water one degree Fahrenheit.

In the metric system the unit to measure heat energy is the kilogram-calorie. One calorie is the heat required to raise the temperature of one kilogram of water one degree Celsius.

(W) 14. Determine the number of Btu required to raise the temperature of:

a. 2 pounds of water 1°F

b. 1 pound of water 2°F

c. 5 pounds of water 3°F

d. 64 pounds of water 15°F

(W) 15. Determine the number of calories required to raise the temperature of:

a. 3 kilograms of water 1°C

b. 1 kilogram of water 3°C

c. 25 kilograms of water 7°C

d. 100 kilograms of water 20°C

Calculations show that at the present cost of electricity it costs 1.3¢ to obtain 1 000 Btu of heat energy or 5.2¢ to obtain 1 000 calories of heat energy.

The following table gives the number of Btu and calories required to heat water to be used for various purposes in the home:

PURPOSE	Btu	CALORIES
TAKE A BATH	9 000	2 270
TAKE A SHOWER	6 100	1 540
BRING WATER TO A BOIL IN A LARGE COOKING POT	1 270	320

(D) 16. Compute the approximate cost of electricity for:

a. taking a bath

b. taking a shower

c. boiling water in a large pot.

(D) 17. Suppose a family of four takes showers each day rather than baths. Determine the monthly savings gained by taking showers. (Use 30 days for 1 month.)

One way to reduce the amount of energy consumed to heat water is to use solar energy.

At noontime the amount of solar energy falling on a surface at <u>right angles</u> to the sun's rays is about:

429 Btu per square foot per hour

1 164 calories per square meter per hour.

Therefore, if you had a 100 square-foot solar heating panel, the amount of heat energy that the panel could produce in one hour would be:

$$100 \text{ sq ft} \times 429 \text{ Btu/ft}^2\text{/hour} = 42\,900 \frac{\text{Btu}}{\text{h}}$$

Since the panel could not be 100% efficient you would not get this much heat out of it. So, if we assume 40% efficiency, the amount of heat the panel could produce per hour would be:

$$42\,900 \times 0.40 = 17\,160 \frac{\text{Btu}}{\text{h}}$$

(4 324 calories/hour)

This is enough hot water to take one bath, one shower, and bring water to boil in a large cooking pot.

(D) 18. Florida Power and Light Company estimates that the average home requires 400 kilowatt-hours of electricity per month for heating water. Using a cost of 4.5¢ per kilowatt-hour, compute the average cost per household to heat water during the period of:

a. 1 month

b. 1 year

c. 10 years.

(P) 19. Some solar water heating systems designed to provide hot water for the average household cost about $900 to install. Assuming the solar system will reduce the cost of electricity for heating water by 70 percent, determine the money saved during the period of:

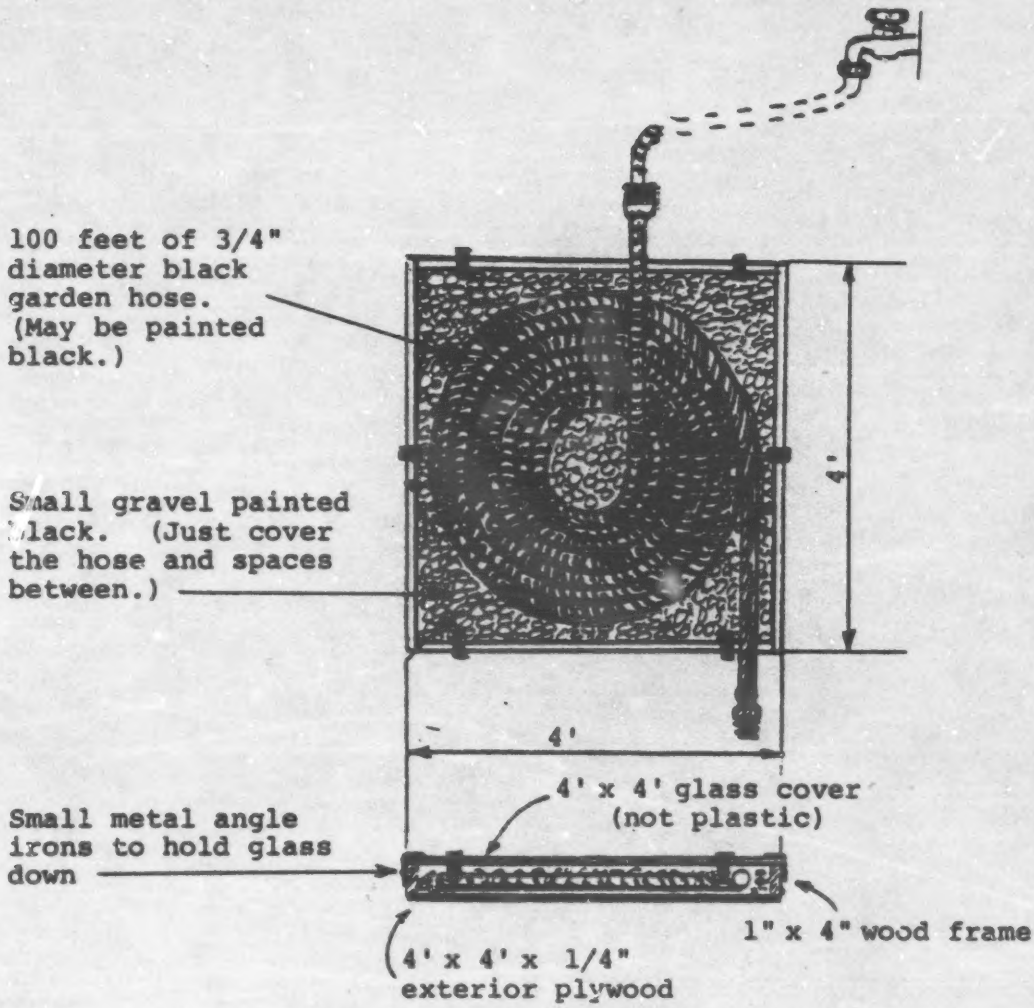
a. 1 month

b. 1 year

c. 10 years.

(D) 20. Compute the length of time it would take for the solar water heating system to pay for itself.

HOW TO MAKE A SMALL, LOW COST SOLAR WATER HEATER


100 feet of 3/4" diameter black garden hose. (May be painted black.)
Small gravel painted black. (Just cover the hose and spaces between.)
Small metal angle irons to hold glass down
4'
4'
4' x 4' glass cover (not plastic)
1" x 4" wood frame
4' x 4' x 1/4" exterior plywood

INSTRUCTION FOR OPERATING:

Place the solar heater in a convenient place facing the sun and prop it up so it is at right angles to the sun's rays. Connect your garden hose to the heater. Turn the hose on until water comes out of the heater and then turn it off. Wait 15 minutes and you will have 2.3 gallons of water heated to about 110°F.

IV

OUR ENERGY RESOURCES

FOSSIL FUELS* - PETROLEUM

Most of the world is in a serious energy crisis simply because our demand for energy will soon exceed our supply of available and useful energy. There are varying estimates as to exactly when our oil and gas will run out. The world is consuming petroleum today at the rate of 18 billion barrels per year (about 6 billion of it by the United States). The world's total reserves are not known today since large oil fields are still being found, but the recoverable known reserves in the free world are estimated to be about 650 billion barrels.

(W) 1. At the current rate of consumption, calculate the approximate number of years left until we exhaust our supply of oil.

(W) 2. Find the average amount of oil used daily by the United States. (Use a 365-day year.)

(W) 3. Assuming that the population of the United States is approximately 216 million, calculate the average

---

*A fossil fuel is either oil, natural gas or coal, formed from the remains of animal and vegetable matter as preserved in the earth.

number of gallons of oil consumed by each citizen per day. (1 barrel of oil = 42 gallons.)

(P) 4. Determine the percent of the world's available supply of oil being used by the United States.

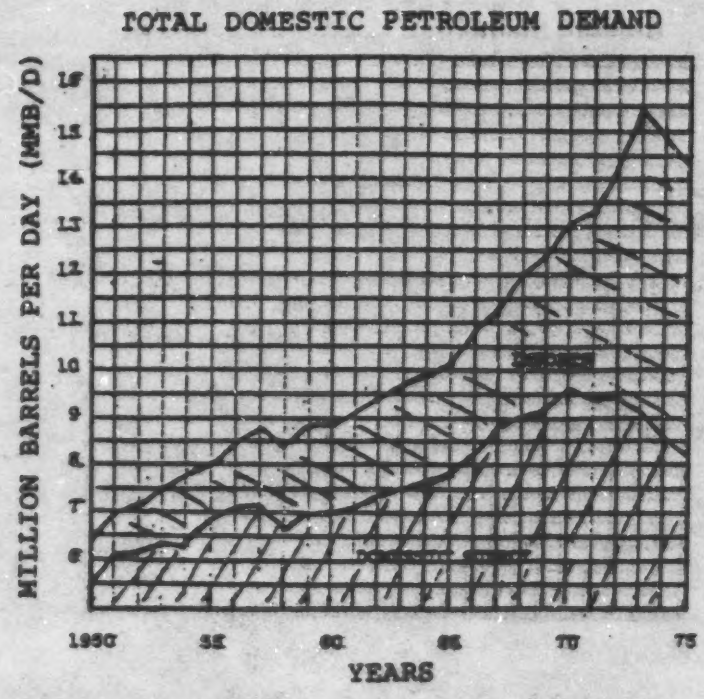
(P) 5. Passenger cars consume nearly 30 percent of all oil used in the United States. Determine the number of barrels of oil consumed by passenger cars on a

a. yearly basis

b. daily basis.

Because of relatively low prices, air pollution restrictions, and the growing use of automobiles, petroleum demand in the United States has increased at an annual rate of 4.6 percent in the 1960's and early 1970's. Meanwhile, the availability of inexpensive imported oil has served to limit domestic production which peaked at 9.6 million barrels per day (MMB/D) in 1970 and has been declining ever since to the current production of 8.2 MMB/D.

The combination of declining domestic production and rising demand has led to a rapid growth of imports as is illustrated by the following graph.



(S) 6. Use the above graph to estimate the number of barrels of oil that were used daily by the United States during the following years:

a. 1950

b. 1960

c. 1970

d. 1975

(S) 7. Use the above graph to estimate the number of barrels of oil that were imported daily by the United States during the following years:

a. 1950

b. 1960

c. 1970

d. 1975

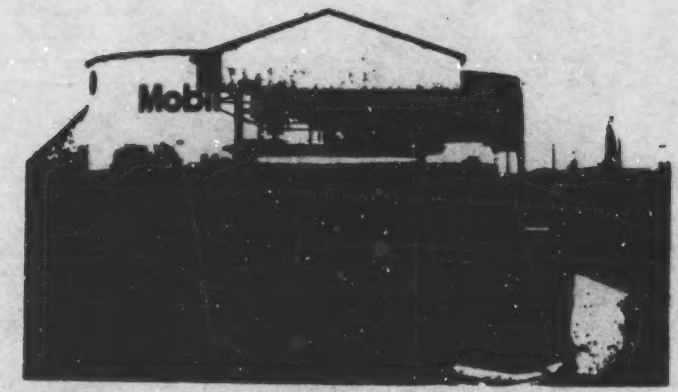
(P) 8. Compute the percent of daily consumption of oil that was represented by oil imports during the following years:

a. 1950

b. 1960

c. 1970

d. 1975



The Arab oil embargo in 1973/1974 demonstrated that the United States is vulnerable to severe supply disruptions and oil price increases. The cost of a barrel of imported has increased from approximately $2.42 in 1970 to $12.33 in 1975. During that same period of time, domestic oil increased in cost from $3.18 per barrel in 1970 to $7.56 per barrel in 1975.

(D) 9. Determine the actual increase in cost, from 1970 to 1975, for a barrel of:

a. imported oil

b. domestic oil.

(P) 10. Determine the percent increase in cost, from 1970 to 1975, for a barrel of:

a. imported oil

b. domestic oil.

(D) 11. Assuming a 365-day calendar year, calculate the total cost for imported oil to the United States during the year:

a. 1970 (3.5 MMB/D)

b. 1975 (6.2 MMB/D)

(D) 12. Assuming the population of the United States to be 200 million in 1970 and 216 million in 1975, calculate the average cost per citizen per year for imported oil during the year:

a. 1970

b. 1975.

(P) 13. From the graph, determine the number of Quads of energy we use annually that are obtained from the following resources:

a. imported oil

b. domestic oil

c. natural gas

d. coal

e. nuclear power

f. hydro-electric power

(W) 14. It is estimated that by the year 2000, our energy consumption in the United States will double. Compute the number of Quads of energy we will be using at that time.

15. Using 150 Q as the estimated United States energy consumption for the year 2000, calculate:

(W) a. the actual increase, in Quads, of energy consumption for the year 2000, as compared to 1975.

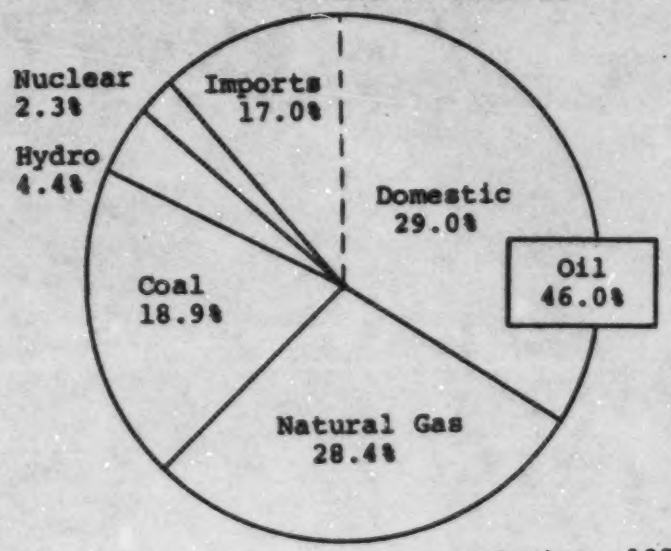
(F) b. the ratio of the actual increase in energy consumption to our 1975 consumption.

(P) c. the percent of increase in use of energy projected for the year 2000 over the year 1975.

FOSSIL FUELS - GAS

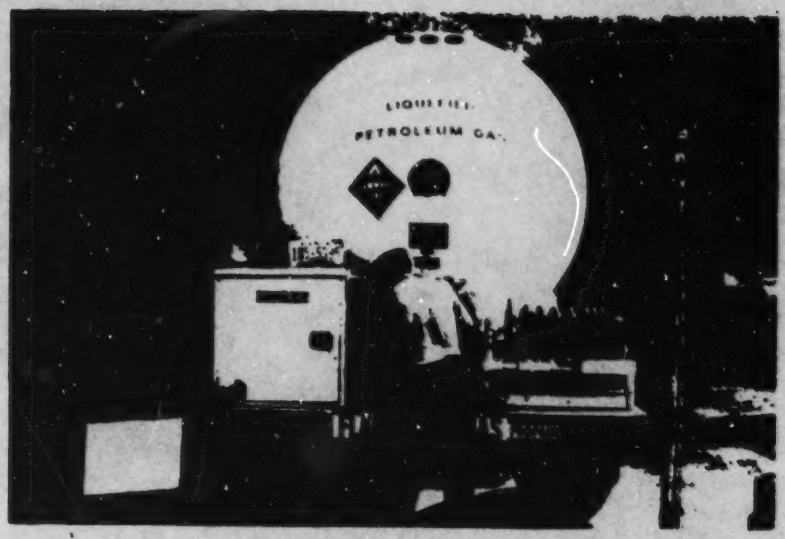
The circle graph below shows the makeup of our energy sources. While oil often receives the greatest attention, natural gas and oil are equal as our two largest domestic sources of energy. Therefore, natural gas is very important to our energy situation.

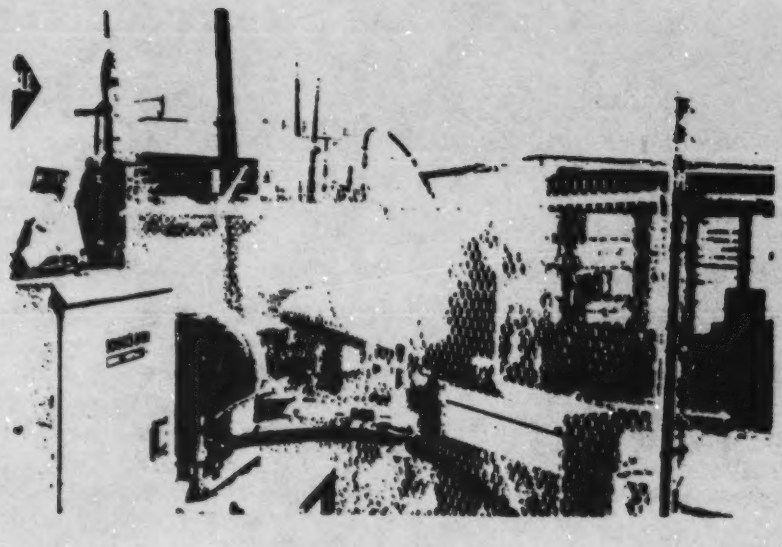
UNITED STATES ENERGY SOURCES



Source: United States Bureau of Mines 1975

Because oil is measured in barrels, gas in cubic feet, coal in tons, etc., it is necessary to arrive at a common unit to equate the total amount of energy each of these resources contribute to our total needs. We will use the Quad (abbreviated Q) as this common unit of measure of energy which is equal to 10^{15} Btu of energy. Currently the United States is using 75 Q of energy each year.


PETROLEUM GA



FOSSIL FUELS - COAL

Coal is clearly our most abundant domestic fossil resource with identified reserves sufficient to meet the needs of our nation for an estimated 200 years. Some estimates of our total domestic coal reserves go as high as three trillion tons. At present production rates, such amounts could last nearly 5000 years. Not all of this supply is recoverable. The more meaningful estimates deal with recoverable reserves. The amount of economically recoverable reserves are estimated at 300 billion tons.

Estimated current annual production capacity of the coal industry is about 700 million tons. By 1985, this capacity is expected to increase by an additional 535 million tons.

(W) 16. Determine the amount of coal estimated to be produced during 1985.

(F) 17. Write the ratio of the additional number of tons of coal estimated to be produced by 1985 to that which is produced at the present.

(P) 18. Compute the percent of increase of coal production anticipated for the year 1985.

There is no guarantee that actual production in 1985 will be able to match the anticipated productive capacity.

For example, coal production in the United States increased by only 6 percent in 1975, as compared to 1974. This was 51 million tons less than that which was expected.

(P) 19. If 603 million tons of coal were produced in 1974, compute the number of tons of coal produced in 1975.

(W) 20. Compute the number of tons of coal production that had been anticipated for 1975.

One of the reasons why projected coal production and actual production are not always the same is due to the type of mining used in the production of coal. Basically, there are two kinds of coal mining: surface mining and underground (or deep mining). Each method accounts for about half of the coal produced in the United States. Surface mining is on the average three times more productive than deep mining. That is, three times as much coal is produced per man hour through surface mining as compared to deep mining.

(W) 21. Calculate the number of man hours of deep mining required to produce the same amount of coal as is produced during 100 man hours of surface mining.

Most new surface mines are located in the western part of the United States. While it is true that it takes less man hours to produce coal from surface mines, the cost of transporting this coal to the eastern part of the United

States increases the price of the coal substantially. Also, though most western coal is low in sulfur content (making it better for our environment), most of it is low energy sub-bituminous coal. A ton of this type of coal has only 3/4 the number of Btu as eastern coal.

(F) 22. Compute the number of tons of eastern coal it would take to produce the same number of Btu as 5 000 tons of western coal.

(F) 23. Compute the number of tons of western coal that it would take to produce the same number of Btu as 1 000 tons of eastern coal.

The chart below illustrates the United States' coal reserves and Btu output by region:

REGION	BILLION TONS	QUADRILLION Btu (Quads)
EAST	202.3	5 000
WEST	234.3	4 600

(D) 24. Use the above chart to calculate the tonnage difference in coal reserves between the eastern and western parts of the United States.

(W) 25. Use the above chart to calculate the Btu difference between the eastern and western parts of the United States.

(D) 26. Calculate the number of Quads per billion tons of coal obtained from:

a. eastern coal reserves

b. western coal reserves.

NUCLEAR ENERGY

By splitting the atoms of uranium or plutonium (fission), nuclear reactors produce a tremendous amount of heat energy. This energy can be used to generate electricity. In 1975, nuclear reactors represented about 9 percent of our country's electrical generating capacity. By 2000, it is estimated that nuclear power plants will account for about 45 percent of our electric power output.

This source of energy is one of the most promising solutions to our energy problems. Unfortunately, it is also a very controversial source of energy because of public fear of the results of a nuclear accident. Acceptance by the public will depend on the action of government and industry to resolve present uncertainties regarding the safety of nuclear power plants.

In 1975, 26.2 percent of the total fuel consumed in the United States (75 Quads) was used to generate electrical energy. By the year 2000 it is estimated that energy requirements in the United States will increase to 150 Quads. Using this data, calculate:

(P) 27. the number of Quads of energy used in the United States in 1975 to produce electricity.

(P) 28. the number of Quads of electrical energy obtained through nuclear sources in 1975.

(P) 29. the anticipated number of Quads of energy that will be produced from nuclear sources in the year 2000.

30. If unfavorable public acceptance limits the use of nuclear power plants to only a 10 percent increase from 1975 to 2000, determine how many Quads of energy will have to be obtained from other sources.

Fort Lauderdale News, Monday, Nov. 7, 1977

Decisions

High Court To Rule On Nuclear Liability

by Associated Press

WASHINGTON — The Supreme Court agreed today to decide whether Congress may place a $560-million ceiling on liability that operators of nuclear power plants would face from a major nuclear accident.

The justices said they will study a ruling by a federal judge in North Carolina last March striking down as unconstitutional the Price-Anderson Law passed by Congress in 1957.

V.

APPENDIX

GLOSSARY OF WORDS AND TERMS YOU SHOULD KNOW

acceleration

The rate at which a moving object changes its speed or direction of motion.

amperes

The quantity of electricity that passes a given point in one second. (1 ampere = 6.28×10^{18} electrons per second)

British thermal unit (Btu)

The heat energy required to raise the temperature of one pound of water one degree Fahrenheit.

Calorie (C)

The heat energy required to raise the temperature of one kilogram of water one degree Celsius.

energy

The ability or potential to do work. Energy cannot be created or destroyed—it can only be converted to another form.

energy efficiency ratio (EER)

A formula for rating the efficiency of an air conditioning unit. $\text{EER} = \frac{\text{Btu per hour}}{\text{watts}}$

The EER range is from 4.7 to 12.2. For example: 6 to 7 is fair; 8 to 9 is good; 10 or more is excellent.

foot-pounds (ft-lbs)

The unit of mechanical work or energy in the customary system of measurement. One foot-pound of work is accomplished when a force of one pound is applied through a distance of one foot.

fossil fuels

The combustible materials formed many years ago by the decay of plant and animal life (organic matter). Petroleum, natural gas, and coal are fossil fuels.

heat

The energy a substance contains because of the total mass and motion of its atoms or molecules.

horsepower (H.P.)

A unit for measuring power in the customary system of measurement. One H.P. can do 550 ft-lbs of work per second.

insulation

A substance that acts as an effective barrier to the transfer of energy from one material to another.

joule

A unit of energy or work in the metric system. The work done when a force of one newton is applied through a distance of one meter.

kilowatt (kw)

The unit of electrical power. One kilowatt represents 1 000 ampere-volts.

kilowatt-hour (kw-hr)

The unit of electrical energy. One kw-h represents 1 000 ampere-volts of electrical power operating for one hour.

kilogram-meter (kg-m)

A unit for measuring work or energy in the metric system. One kg-m of work is accomplished when a force of one kilogram is applied through a distance of one meter.

kinetic energy

The energy something has because of the mass of the object and its motion (mechanical energy) or the motion of its atoms or molecules (heat energy).

newton

The metric unit of force. The force required to accelerate a free body having a mass of one kilogram at the rate of one meter per second per second.

potential energy

The energy something has because of its position or state. (Water behind a dam has potential energy of position. Gasoline in a tank has potential energy

because of its chemical state).

power

The rate at which work could be or is being accomplished. Power is equal to the work accomplished divided by the time it took to do the work.

Quad

A unit of measurement used as a convenient way of talking about large quantities of energy. One Quad is equal to 10^{15} Btu.

solar radiation

The energy radiated by the sun in the form of electromagnetic waves. The sun's radiation contains ultraviolet rays, light rays, and infra-red rays (heat), as well as other forms of electromagnetic energy.

temperature

The average speed of motion of the atoms or molecules that make up a substance. At -273°C all atomic and molecular motion ceases and the substance contains no heat energy.

volt

The electric pressure that drives electrons through a conductor. It is similar in nature to the pressure that causes water to flow through a pipe.

watt

The unit for electric power. One watt is equal to one ampere of electrical current under a pressure of one volt. (watts = amperes x volts)

work

Work is accomplished whenever a force is exerted through a distance or whenever the speed of motion (energy) of a substance is changed.

ENERGY CONVERSION NUMBERS

ONE FOOT-POUND OF MECHANICAL ENERGY IS APPROXIMATELY EQUIVALENT TO:

0.14 kilogram-meters

3.77×10^{-7} kilowatt-hours

5.05×10^{-7} horsepower-hours

1.28×10^{-3} British thermal units

3.2×10^{-4} Calories (kilocalories)

ONE KILOGRAM-METER OF MECHANICAL ENERGY IS APPROXIMATELY EQUAL TO:

7.23 foot-pounds

2.72×10^{-6} kilowatt-hours

3.65×10^{-3} horsepower-hours

9.30×10^{-3} British thermal units

2.34×10^{-3} Calories

ONE HORSEPOWER-HOUR OF MECHANICAL ENERGY IS APPROXIMATELY EQUAL TO:

1.98×10^{6} foot-pounds

2.74×10^{5} kilogram-meters

0.75 kilowatt-hours

2 545 British thermal units

641 Calories

ONE KILOWATT-HOUR OF ELECTRICAL ENERGY IS APPROXIMATELY EQUAL TO:

2.65×10^{6} foot-pounds

3.67×10^{5} kilogram-meters

1.34 horsepower-hours

3 413 British thermal units

860 Calories

ONE BRITISH THERMAL UNIT OF HEAT ENERGY IS APPROXIMATELY EQUAL TO:

777.77 foot-pounds

107.56 kilogram-meters

3.93×10^{-4} horsepower-hours

2.93×10^{-4} kilowatt-hours

0.252 Calories

ONE CALORIE OF HEAT ENERGY IS APPROXIMATELY EQUAL TO:

3.09 foot-pounds

0.43 kilogram-meters

1.56×10^{-6} horsepower-hours

1.16×10^{-6} kilowatt-hours

3.968 British thermal units

SOLAR RADIATION (AT 90° TO SUN'S RAYS)

1 164 $C/m^2/h$

429.6 $Btu/ft^2/h$

HEAT ENERGY OF COAL

HIGH GRADE ANTHRACITE:	14 400 Btu/lb
BITUMINOUS COAL:	9 700-15 000 Btu/lb

ANSWER KEYS

II ENERGY FOR MOVING THINGS

1. 3.71 kilogram-meters

2. a. 3 000 foot-pounds
   b. 9 000 foot-pounds
   c. 30 000 foot-pounds

3. 20 000 foot-pounds

4. 60 foot-pounds

5. 54.6 kilogram-meters

6. a. 27 miles per gallon
   b. i. 24.2 gallons
      ii. 22.4 gallons
   c. $1.15

7. a. 555.6 gallons
   b. 24.8 miles per gallon
   c. 604.8 gallons
   d. $31.44

8. a. 131.5 gallons
   b. 104.9 gallons

9. $18.06

10. a. 66 $\frac{\text{foot-pounds}}{\text{second}}$
    b. 99 $\frac{\text{foot-pounds}}{\text{second}}$
    c. 198 $\frac{\text{foot-pounds}}{\text{second}}$

11. a. 10.2 $\frac{\text{kilogram-meters}}{\text{second}}$
    b. 13.6 $\frac{\text{kilogram-meters}}{\text{second}}$
    c. 20.4 $\frac{\text{kilogram-meters}}{\text{second}}$
    d. 40.8 $\frac{\text{kilogram-meters}}{\text{second}}$

12. a. 120 $\frac{\text{foot-pounds}}{\text{second}}$
    b. 180 $\frac{\text{foot-pounds}}{\text{second}}$
    c. 240 $\frac{\text{foot-pounds}}{\text{second}}$

13. a. 7 horsepower
    b. 15 horsepower
    c. 50 horsepower

14. a. 1 375 foot-pounds per second
    b. 30 250 foot-pounds per second
    c. 71 500 foot-pounds per second
    d. 123 750 foot-pounds per second

15. a. 1.22 hours or 1 hour 13 minutes
    b. 0.60 hour or 36 minutes
    c. 0.36 hour or 22 minutes
    d. 0.31 hour or 19 minutes

16. a. 0.7 gallons
    b. 0.8 gallons
    c. 1.0 gallons
    d. 1.3 gallons

17. a. 45¢
    b. 51¢
    c. 64¢
    d. 83¢

18. a. 14 trips with 5 H.P. engine
    12 trips with 9.8 H.P. engine
    10 trips with 25 H.P. engine
    7 trips with 35 H.P. engine
    b. Answers will vary.

19. a. 9.0 kilometers per liter
    b. 8.5 kilometers per liter

20. a. 50 liters
    b. 41.2 liters
    c. 38.9 liters

21. a. $7.95
    b. $6.55
    c. $6.19

ENERGY FOR MOVING THINGS - ANSWER KEY (Continued)

22. a. 14 mpg
    b. 19 mpg
    c. 8.5 mpg

23. a. 22.50 hours or 22 hours 30 minutes
    b. 16.36 hours or 16 hours 22 minutes
    c. 12.86 hours or 12 hours 52 minutes

24. a. 47.4 gallons
    b. 51.4 gallons
    c. 105.9 gallons

25. a. $32.66
    b. $35.41
    c. $72.97

26. 3.93 mpg
    2.54 mpg
    2.07 mpg
    1.69 mpg
    1.38 mpg
    1.24 mpg
    1.03 mpg

27. Graphs will vary.

28. a. 6.37 hours or 6 hours 22 minutes
    b. 4.26 hours or 4 hours 16 minutes
    c. 3.18 hours or 3 hours 11 minutes

29. a. 12.7 gallons
    b. 36.2 gallons
    c. 48.5 gallons

30. a. $8.37
    b. $23.86
    c. $31.96

31. Answers will vary.

32. a. 480 000 foot-pounds
    b. 1 080 000 foot-pounds

33. a. 128 million gallons
    b. $81 792 000

34. a. 0.85 kilometers per liter
    b. 3 miles per gallon
    c. 200 gallons
    d. $127.80
    e. 400 million gallons
    f. $255 600 000

III ENERGY FOR HEAT AND LIGHT - ANSWER KEY

1. 989 watts

2. 3.83 amperes

3. 1 210 watts

4. 9.73 amperes

5. a. 1.2 kw-h
   b. 0.3 kw-h
   c. 2.0 kw-h
   d. 3.54 kw-h

6. $135

7. a. 43.2 kw-h
   b. $1.94

8. $0.41

9. a. 1 440 kw-h
   b. $64.80
   c. $16.85
   d. $5.18
   e. $42.77

10. $90

11. a. $19.80
    b. $6.30

III ENERGY FOR HEAT AND LIGHT - ANSWER KEY (Continued)

12. a. 414.74 kw-h
    b. $18.66

13. 29 square inches

14. a. 2 Btu
    b. 2 Btu
    c. 15 Btu
    d. 960 Btu

15. a. 3 calories
    b. 3 calories
    c. 175 calories
    d. 2 000 calories

16. a. 11.7¢ - 11.8¢
    b. 7.9¢ - 8.0¢
    c. 1.7¢

17. $4.56

18. a. $18
    b. $216
    c. $2160

19. a. $12.60
    b. $151.20
    c. $1512.00

20. Approximately 6 years.

IV OUR ENERGY RESOURCES - ANSWER KEY

1. 36 years

2. 16.4 million barrels

3. 3.2 gallons

4. 33 1/3%

5. a. 1.8 billion barrels
   b. 4.9 million barrels

6. a. 6.4 million
   b. 8.8 million
   c. 13.1 million
   d. 14.4 million

7. a. 0.9 million
   b. 1.8 million
   c. 3.5 million
   d. 6.2 million

8. a. 14%
   b. 20%
   c. 27%
   d. 43%

9. a. $9.91
   b. $4.38

IV OUR ENERGY RESOURCES - ANSWER KEY (Continued)

10. a. 409.5%
    b. 137.7%

11. a. $3.09 billion
    b. $27.90 billion

12. a. $15.45
    b. $129.17

13. a. 12.75 Q
    b. 21.75 Q
    c. 21.30 Q
    d. 14.175 Q
    e. 1.725 Q
    f. 3.3 Q

14. 150 Q

15. a. 75 Q
    b. $\frac{75}{75}$ or $\frac{1}{1}$
    c. 100%

16. 1 235 million tons

17. $\frac{535}{700}$ or $\frac{107}{140}$

18. 76.4%

19. 639.18 million tons

IV OUR ENERGY RESOURCES - ANSWER KEY (Continued)

20. 690.18 million tons

21. 300 man hours

22. 3 750 tons

23. 1 333 1/3 tons

24. 32 billion tons

25. 400 Quadrillion Btu

26. a. 24.7
    b. 19.6

27. 19.65 Q

28. 1.77 Q

29. 17.69 Q

30. 37.35 Q

BIBLIOGRAPHY

A Critical National Choice: New Energy Horizons or Horizontal Disintegration. American Petroleun Institute, 2101 L Street, N.W., Washington, D.C. 20037. April 1977.

A Floridian's Guide to Solar Energy. State of Florida Department of Administration, State Energy Office, Data Collection and Analysis Section, 108 Collins Building, Tallahassee, Florida 32304. December 1975.

America's Energy Dilemma: Facts Versus Fallacies. Independent Petroleum Association of America, 1101 Sixteenth Street, N.W., Washington, D.C. 20036. May 1977.

Bethe, H.A. The Necessity of Fission Power. Scientific American Offprints, Volume 1, pp 21-31, January 1976. San Francisco, California 94301: W. H. Freeman and Company.

Continuing Energy Crisis in America. Congressional Quarterly, 1414 22nd Street, N.W., Washington, D.C. 20037. 1975.

Eaton, William. Solar Energy. Energy Research and Development Administration, Office of Public Affairs, Washington, D.C. 20545. 1976.

Edelson, Edward. Alternate Energy Sources: Electric Energy Issues and Answers. Edison Electric Institute, 90 Park Avenue, New York, N.Y., 1975.

Energy - Economics Workshop Report. Sponsored by Florida State Department of Environmental Education and Florida Power and Light. October 15-16, 1976.

Energy Options to the Year 2000. Chemical Engineering. McGraw-Hill, Inc., January 3, 1977.

Environmental Impact of Electrical Power Generation, The: Nuclear and Fossil. United States Energy Research and Development Administration, Pennsylvania Department of Education, 1975.

Guide to National Petroleum Council Report on United States Energy Outlook. Library of Congress Catalog Card No. 72-172997, 1973.

Handbook of Moving Air, The. American Ventilation Association, P.O. Box 7464, Houston Texas 77008. 1977.

Henderson, G.E. Understanding Electricity and Electrical Terms. American Association for Vocational Instructional Materials, 120 Engineering Center, Athen, Georgia 30602. 1970.

Insulation Story, The. National Mineral Wool Insulation Association, 382 Springfield Avenue, Summit, New Jersey 07901. 1977.

National Energy Outlook. 1976 Executive Summary, Federal Energy Administration, United States Government Printing Office, Washington, D.C. 20402.

New Frontiers for Energy. Project 76, American Petroleum Institute, Public Relations Department, 1801 K Street, N.W., Washington, D.C. 20006.

Nuclear Power and The Environment: Questions and Answers. American Nuclear Society, June 1976.

Oil Producing Industry In Your State, The. Independent Petroleum Association of America, 1101 Sixteenth Street, N.W., Washington, D.C. 1976.

Our Energy: Problems and Solutions. Energy Conservation Research, 9 Birch Road, Malvern, Pennsylvania 19355. 1977.

Parady, W. Harold, and J. Howard Turner. Electric Energy. American Association for Vocational Instructional Materials, 120 Engineering Center, Athens, Georgia 30602. 1976.

Scientific Conversion Tables. FACT on Educational Service of Florida Power and Light Company, Miami, Florida.

Solar Energy. Energy Research and Development Administration pamphlet No. 11, Office of Public Affairs, Washington, D.C. 20545. 1976.

Solar Energy and Your Home. United States Department of Housing and Urban Development. April 1977.

Transitional Storm, The: Electric Energy: Issues and Answers. Edison Electric Institute, 90 Park Avenue, New York 10016. September 1976.

United States Energy: Yesterday, Today, and Tomorrow. American Petroleum Institute, 2101 L Street, N.W., Washington, D.C. 20037. January 1977.

United States Energy Resources and Need. Americans for Energy Independence Energy Issues Communique No. 2, 1250 Connecticut Avenue, N.W., Suite 502, Washington, D.C. 20036. 1976.